भारतीय मानक

जिब क्रेन — रीति संहिता

Indian Standard

JIB CRANES — CODE OF PRACTICE

ICS 53.020.20

© BIS 2004

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

February 2004

Price Group 10

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Cranes, Lifting Chains and Its Related Equipment Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard covers mechanical and electrical aspects related to design, manufacture, erection and testing of the jib cranes required for the shop floor and general workshop applications like pillar, wall bracket jib cranes including moving cantilever wall cranes.

There is no ISO/IEC Standard on the subject. This standard has been prepared based on indigenous manufacturers data/practices prevalent in the field in India.

The new classifications of cranes now coming into effect as per IS 13834 (Part 1) : 1994 'Cranes — Classification: Part 1 General' and the classification presently in use can approximately be compared as follows :

Old Classification	*New Classification as per IS 13834 (Part 1)*
I	M 1
II	M 4
III	M 6

Classification of jib cranes of each mechanism shall be determined in accordance with IS 13834 (Part 4) : 1993 'Cranes — Classification : Part 4 Jib cranes' limited to M6 (old class III) only.

For ease of reference this standard has been divided into four sections as follows :

Section 1 Mechanical aspects
Section 2 Structural aspects
Section 3 Electrical requirements
Section 4 Inspection and testing

The Indian Standards listed in Annex A are necessary adjuncts to this standard.

The composition of the Committee responsible for formulation of this standard is given at Annex E.

Indian Standard

JIB CRANES — CODE OF PRACTICE

1 SCOPE

This Code covers mechanical, electrical inspection and testing requirements relating to the design, manufacture and erection of stationery swiveling jib cranes of all types for shop floor and general purpose applications.

2 REFERENCES

The standards listed below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below :

IS No.	*Title*
325 : 1996	Specification of three phase induction motors (*fifth revision*)
807 : 1976	Code of practice for design, manufacture, erection and testing (structural portion) of cranes and hoists (*first revision*)
1231 : 1974	Dimensions of three phase foot mounted induction motors (*third revision*)
1875 : 1992	Carbon steel billets, blooms, slabs and bars for forgings (*fifth revision*)
2062 : 1992	Steel for general structural purposes (*fourth revision*)
2223 : 1983	Dimensions of flange mounted ac induction motor (*first revision*)
3177 : 1999	Code of practice for electric overhead travelling cranes and gantry cranes other than steel work cranes (*second revision*)
3832 : 1986	Hand operated chain pulley blocks (*second revision*)
3938 : 1983	Specification for electric wire rope hoists (*second revision*)
4460 (Parts 1 to 3) : 1995	Gears — Spur and helical gears calculation of lead capacity (*first revision*)
8500 : 1991	Structural steel micro-alloyed (medium and high strength qualities) (*first revision*)
13473 (Part 1) : 1992	Cranes — Vocabulary: Part 1 General

3 TERMINOLOGY

3.1 General

For the purpose of this standard the definitions given in IS 13473 (Part 1) and following text shall apply. If there are common terms, the definitions given in this standard, shall prevail.

3.2 Normal Service Conditions

Normal service condition shall satisfy the following conditions :

a) Indoor and outdoor applications should be with normal air of normal humidity and free from contamination.

b) Ambient temperature should be between 0°C and 40°C and if the service conditions are beyond the normal conditions, suitable de-rating factors shall be applied.

c) Altitude should not exceed 1 000 m above sea level.

4 TECHNICAL INFORMATION

4.1 Information to be Supplied with the Enquiry or Order

Information regarding the conditions under which the jib crane is to be used together with particulars laid down in Annex B, shall be supplied with the enquiry or order.

4.2 Information to be Supplied by the Manufacturer

The manufacturer shall supply with the tender information regarding the construction of the jib crane, according to the proforma laid down in Annex C, including clearance diagrams, loads and turning moments on foundation and mounting due to eccentric loading.

4.3 Information to be Provided Prior to Installation and Commissioning of the Crane

The manufacturer shall provide the following information while commissioning the crane :

a) General arrangement drawing showing all leading dimensions and installation details,
b) Circuit and wiring diagram,
c) Operating and maintenance instructions,
d) Recommended spares list,
e) Test certificate,
f) Full technical detail of wire rope used, and
g) Any other information mutually agreed to between the manufacturer and the purchaser.

5 MARKING AND LOAD INDICATION

5.1 Identification

The crane shall bear one or more plaques on which the following information shall be inscribed :

a) Manufacturer's name;
b) Machine serial No.;
c) Year of manufacture;
d) The word 'Jib Crane' followed by a blank space, so that the purchaser may conveniently insert his code number, if any;
e) The safe working load, in kgs; and
f) Last date of test.

5.1.1 *Name Plate*

This plaque shall be readily legible from the ground or floor level and shall be located in a prominent position on jib arm.

SECTION 1
MECHANICAL ASPECTS

6 DESIGN OF CRANE MECHANISM

6.1 General

The design of the component parts of the mechanism relating to each jib crane motion shall include due allowance for the effects of the duty which the mechanism will perform in service.

6.2 The design of crane mechanism shall be as per Section 2 of IS 3177. However, duty classification for jib cranes shall be limited to M6.

6.3 Selection of Components

All components shall be selected or designed under loads and loading conditions specified in **7.3** of Section 2 of IS 3177.

6.4 Mechanical Details

In designing the mechanism of the crane, special care shall be taken so that all the components are easily accessible for inspection, maintenance and ease of replacement with minimum down time. Each mechanism of jib crane shall preferably be modular in construction with built-in facilities for easy dismantling and maintenance of each assembly as an independent unit. Sizes of all components like wheels, brakes, sheaves, etc shall be selected from preferred number series.

6.5 Structural Aspects

6.5.1 The crane shall be designed in accordance with IS 807 for the jib column and jib arm of the crane.

6.5.2 The structural steel material for jib crane structure shall conform to IS 2062 and IS 8500.

6.5.3 The boom of the jib crane shall be from section or fabricated type with rolled sections or tubular sections.

6.5.4 The design of the boom shall be such that the vertical deflection caused by the maximum rated load with the hoist at the maximum jib radius position on the boom, shall not exceed 1/250 of the boom length. The measurement of the deflection shall not be taken on the first application of the load, but on subsequent applications.

6.5.5 The column of the jib crane shall be made of heavy duty steel tube or fabricated/lattice structure to ensure minimum deflection at full load. Proper bearing housing block, for housing required bearing for supporting the boom, shall be provided at the top or at suitable location.

6.5.6 The jib arm support bearing will be either anti-friction ball/roller bearings (or bush type bearing) as per design/client's requirements.

6.5.7 Base plate of the column should be provided with drilled holes of appropriate size for fixing the jib crane on the foundation and bolts.

6.5.8 The foundation bolts shall be so designed, that 50 percent of the bolt provided are capable of taking full load of the jib crane turning moments with impact.

6.5.9 The design of column and boom of the self supported jib crane should be such that over all deflection of the jib crane does not exceed the following limit, when the hoist along with full load is at extreme boom radius :

$$\frac{\text{Boom length } (L) + \text{Column height } (H)}{300}$$

6.5.10 The connection between the boom and the pillar shall be designed suitably to give proper end fixing to the boom and to ensure that the play between moving members is kept to the minimum.

6.5.11 Match marks shall be provided on each part of the structure to facilitate erection and alignment of the crane at the site.

6.6 Slew Drive for the Jib Crane

6.6.1 Slew drive for jib crane will be by manual pull or by motorized electrical as required by the purchaser.

6.6.2 For motorized slew drive, the driving mechanism shall consist of electric motor, which shall be connected to gear box of suitable ratio and capacity by means of a fluid coupling or flexible coupling to take care of over riding. The pinion mounted on the output shaft of the gear box shall engage the ring gear of the pillar for transmitting the torque to the jib. The speed at the tip of the jib boom should be restricted to 15 m/min. Any other design of the slew drive may be employed with mutual consent.

6.6.3 The brake shall be mounted on the input or extension shaft of the gear box. In addition end stoppers are to be mounted on the pillar, suitable limit switches shall be provided in order to restrict the angle of rotation of the jib.

6.6.4 The slew motion of manually operated jib crane shall be carried out by means of pull chain, fixed at the end of the boom.

6.7 Track Wheels

6.7.1 Single flange straight or taper tread type wheels shall be used for under slung type trolley motion. The side clearance between the runway beam flange and wheel shall be 3 to 4 mm on either side.

6.7.2 The wheels shall be made of forged/cast/rolled steel. The minimum hardness of the wheels shall be 250 BHN.

6.8 Bearings

6.8.1 Ball and roller anti-friction bearings shall be used throughout, unless otherwise specified by the purchaser. However, the selection of bearings shall be as per **8.7** of IS 3177.

6.8.2 Anti-friction spherical bearings and ball thrust bearings shall be provided for supporting boom.

6.9 Brakes

Electro-magnetic (EM) brakes of fail-safe type shall be provided for hoist cross travel (CT) and slew mechanism.

6.10 Guards

All couplings open bearings, open slip rings, etc, shall be provided with sheet metal covers opening on strong hinges.

7 SELECTION OF COMPONENTS

7.1 Bearings

7.1.1 *Design*

Due allowance shall be made for impact and side thrusts while selection of bearings. Wherever necessary, spherical seating type separate thrust bearings of suitable dimensions shall be used.

7.1.2 *Ball and Roller Bearings*

Life of ball and roller bearings shall be calculated in accordance with the manufacturer's recommendations and based on the equivalent running time.

7.2 Couplings

7.2.1 All couplings shall be as per **8.9** of IS 3177 and made from steel and shall be designed to suit the maximum torque that may be developed.

7.2.2 Alignment shall be such that solid couplings mate accurately. Flexible/ fluid couplings shall be initially aligned with the same accuracy as solid couplings.

7.2.3 Flexible coupling of fail safe type shall be fitted between motor shafts and gear box extension shafts in case of electric hoist.

7.3 Shafts and Keys

7.3.1 *General*

Shafts and axles shall have ample strength and rigidity and adequate bearing surfaces. They shall, where necessary, be finished smoothly and if shouldered, shall be provided with fillets of as large a radius as possible and/or be suitably tapered.

7.3.2 *Material*

All shafts shall be made of suitable quality of steel as per **8.2.1** of IS 3177.

7.3.3 *Shaft Keys*

Keys, key ways and splines shall be either involute or straight sided and shall conform to the relevant Indian Standards (*see* Annex A). Keys shall be so fitted and secured that they cannot work loose in service.

7.4 Gearing

7.4.1 *Design*

Gears shall be designed in accordance with IS 4460 (Parts 1 to 3) using as a minimum duty factor

for the appropriate mechanism class. *See also* **8.8.1** to **8.8.3** of IS 3177 for technical requirement.

7.4.2 *Types*

The gears in power operated motions shall be machine cut and shall conform to relevant Indian Standards (*see* **7.3.3** and Annex A).

7.4.2.1 All gear shall be made from steel (cast or forged) of 45/55C8 material conforming to IS 1875.

7.4.2.2 Worm wheels or worm wheel rims shall be of bronze or brass and worm shaft shall be of steel of 55C8 material of IS 1875.

7.4.3 *Fixing*

Keys in gear trains shall be so fitted and secured that they cannot work loose in service. Bores for gears and pinions shall be fine machined or ground to size after any heat treatment that may be necessary.

7.5 Gear Boxes

7.5.1 Gear boxes shall be so designed that the gears which they enclose will be automatically lubricated. The gears shall be easily dismantleable and the boxes shall be oil-tight as far as it is reasonably practicable. Grease filled gear boxes shall be properly sealed to avoid the dust from contaminating the grease in the gear box.

7.5.1.1 They shall be of rigid construction and fitted with inspection covers and lifting lugs wherever necessary. Facilities for oil filling, adequate breathing drainage and means of indicating clearly the correct oil levels shall be provided.

7.5.1.2 Gear box legs/face shall be machined and shall be seated and positively located on appropriate level surface, preferably machined except where it is integral or shaft mounted. As far as possible the gear boxes shall be independent modular units. The surface hardness of pinion shall be between 266 to 300 BHN and that for gear shall be between 217 to 255 BHN. Difference of hardness of pinion and gear must not be less than 20 BHN.

7.5.2 *Material for Gear Boxes*

Material for the gear box casing shall be cast iron, cast steel or mild steel, conforming to the relevant Indian Standards (*see* **7.3.3**, **7.4.2** and Annex A). The fabricated gear cases shall be stress relieved before machining.

7.6 Brakes

7.6.1 Brakes shall be capable of bringing the fully loaded jib crane hoist safely to rest in shortest possible time with least possible shock and shall arrest the motion under all service conditions (*see* **8.12.1** of IS 3177).

7.6.2 *Brake Drums and Shoes*

The wearing surface of all brake drums shall be machined and shall be cylindrical, smooth and free from defects. Brake linings shall be effectively and permanently secured to the brake shoes during the effective life of the lining and shall be protected from water, grease, oil, or other adverse effects. Alternatively suitable disc type brakes may be used.

7.6.3 *Springs*

Springs for electro-magnetic (EM) brakes shall be the compression type and shall not be stressed in excess of 80 percent of the torsional elastic limit of the material.

7.6.4 *Traverse Motion*

Every electrically operated traversing motion shall be fitted with an electric/electro-magnetic brake. Limit switches for the traversing motion may be provided by agreement between the supplier and the purchaser.

7.6.5 *Adjustments*

Brakes shall be provided with a simple and accessible means of adjustment to compensate for wear.

7.6.6 *Lifting Devices*

Lifting devices on such jib cranes shall be electric hoist as per IS 3938 or chain pulley block as per IS 3832. The hoisting and traversing motions shall be governed by IS 3832 and IS 3938 respectively.

8 GUARDING AND WEATHER PROTECTION

8.1 Guarding

All gear wheels, pinions and chain drives shall be encased unless such parts are so situated in relation to the structure of the crane so as to be as safe as if complete encasement were provided.

8.1.1 Effective guards shall be provided wherever necessary for revolving shafts, couplings and external gears.

8.2 Weather Protection

For outdoor cranes, all electrical and mechanical equipment shall be adequately protected from the weather. All weather proof covers shall be easily removable type.

8.3 Painting

8.3.1 Before dispatch of the jib crane, the complete crane covering, structural, mechanical and electrical parts shall be thoroughly cleaned of all dirt, grease,

scale and rust. A single coat of primer shall be given to all parts exposed to weathering effects which are not already treated earlier or effectively lubricated. At least one additional finishing coat of paint for indoor cranes and at least two additional finishing coats of paint for outdoor cranes, of colour of customer's choice, shall be given on all primer painted surfaces.

8.3.2 All moving parts up to the height of 5 m from working level or ground shall be painted in golden yellow colour. The bright exposed parts of the crane shall be given one coat of rust inhibitor. Interior of all gear boxes shall be painted with one coat of oil resisting paint. Areas that are inaccessible after assembly or erection shall be treated before assembly or erection.

8.3.3 Where the jib cranes are supplied for use in abnormal working conditions, special protection may be necessary as may be agreed with the user.

8.3.4 Any additional requirements regarding painting shall be as agreed to between the purchaser and the manufacturer.

9 LUBRICATION

Provision shall be made for lubricating all bearings and for gears, chain and sprocket arrangements.

10 LOAD INDICATION AND LOAD LIMITING DEVICES

10.1 Load indication and limiting devices are recommended if weights of objects to be lifted are not known accurately. When fitted they shall sense the load on the crane by means other than the current consumed by hoist motor. If the load lifted is more than safe working load (SWL), load limiting devices shall stop further hoisting operation till the excess load is removed or reduced.

10.2 Purchaser should indicate in the enquiry of load indication and load limiting devices are to be fitted on crane.

SECTION 2

STRUCTURAL ASPECTS

11 STRUCTURAL CONSIDERATIONS

11.1 General

The structural members of the cranes shall be designed in accordance with IS 807.

11.2 The bottom flange of crane girders over which the hoist travels with the load, is subjected to stresses in bending resulting from the concentrated external load and uniformly distributed mass of the girder. Further added are the stresses due to local bending under a concentrated load of wheel pressure. The jib flange is treated as a plate of infinite length rigidly attached to the web along one edge while the other is free.

11.2.1 The procedure for calculation for the combined stresses due to bending and local bending is given in Annex D.

SECTION 3

ELECTRICAL REQUIREMENTS

12 GENERAL

It is necessary that the following particulars are observed in installation and operation of electrical equipment of the cranes so that safety in the operation is ensured :

a) Power voltage used shall not exceed 440 V,

b) All motors, controllers and switch frames shall be earthed,

c) All electric equipment shall be thoroughly protected from dirt, grease and oil and where exposed to the weather shall be thoroughly protected against the weather,

d) Guards for live parts shall be substantial and so located that they cannot be deformed so as to make contact with the live parts, and

e) Name plates shall be fixed in such a manner that it is difficult to remove them.

13 MOTORS

13.1 Torque

The pullout torque of any motor supplied at rated voltage shall preferably be not less than 2.5 times the rated torque.

13.2 Limiting Speeds

Limiting speeds for motors shall not exceed those specified by the motor manufacturer.

13.3 Rating and Enclosure

The rating shall be such that, under the specified service conditions, the temperature rise does not exceed the limits specified in IS 325.

13.3.1 All crane motors shall be totally enclosed with or without fan cooling arrangement and shall conform to IS 1231 or IS 2223 as appropriate. The enclosures shall suit the specified service conditions and shall be stipulated with the enquiry or order. Motors shall be foot or flange mounted type.

13.4 Design and Construction

Motors shall be of robust construction and shall be suitable for frequent reversal, braking and acceleration.

13.4.1 *Mounting*

Motor shall be so located that the brush gear and terminals are accessible for inspection and maintenance and does not restrict the normal ventilation.

13.4.2 *Terminals*

Motor leads shall be brought out from the motor frame to terminals in the terminal box fixed to the motor frame.

13.5 Selection of the motor power shall be in accordance with **10.7.2** of IS 3938.

14 PENDANT PUSH BUTTON CONTROL SWITCH

14.1 General

Cranes control shall be designed so that remote control may be effected by means of a push button pendant switch push button control shall consist of fully magnetic reversing type contactors operated by a momentary contact type push button. The push button shall return to off position, when the pressure is released by the operator. A separate button or a single combination button with suitable arrangement shall be provided for obtaining each speed of multi-speed hoists. The directional contactors shall be mechanically or electrically interlocked.

14.2 Accessibility

All controllers shall be so disposed that the contacts and terminal arrangements are readily accessible for inspection and maintenance purpose.

14.3 Control Switch

The pendant switch shall be capable of withstanding rough handling without being damaged and the cover shall be effectively secured.

14.4 Suspension of Pendant Switch

The weight of the pendant shall be supported independent of the electric cable by means of chain or wire rope. If the pendant is metallic it shall be effectively earthed.

NOTE — A chain or hook does not provide an effective earth connection and should not be relied upon for that purpose.

14.5 The push button station shall be clearly marked as per Table 1 to indicate the function of each button. Push button control voltage shall be not be more than 115 V ac (*see* **11.6** of IS 3938).

Table 1 Marking of Push Button Station

(*Clause* 14.5)

Sl No.	Equipment	Motion	Marking
i)	HOIST	UP ⇑	UP ⇑
		LOWER ⇓	LOWER ⇓
ii)	TROLLEY	LEFT ⇐	LEFT ⇐
		RIGHT ⇒	RIGHT ⇒

14.6 An emergency mushroom head 'STOP' push button shall be provided on the pendant to control incoming power to the crane for emergency safety. In addition 'START ' push button shall be provided to put on the power to the crane. Red and green indicating lights shall be provided on the pendant to indicate the status of incoming power.

15 CONTROL CIRCUITS

15.1 If the main supply is ac and the control circuits are supplied at reduced voltage preferably at 110 V, the supply to those circuits shall be from the secondary winding of an isolating transformer. One pole of this supply shall be earthed and the contactor and relay coils shall be connected to this pole, or other equally effective means shall be adopted to prevent malfunctioning owing to sneak circuits or earth faults.

15.1.1 All controls of hoist shall be so arranged that no motion is inadvertently started when the power is supplied after an interruption.

16 BRAKING

16.1 General

The braking may preferably be fail safe spring loaded electro-magnetic type. Electro-hydraulic brakes may be used on customer's request.

16.1.1 *Electro-magnetic Braking*

The electro-magnetic brake(s) used shall apply automatically when power supply fails or when the push button is released to the 'OFF' position.

16.1.2 *Electro-hydraulic Braking*

Use of electro-hydraulic thruster operated brake is also permissible on all motions of the crane.

16.2 Brake Magnets

The terminals of brake magnets shall be protected from accidental contact and the connections and windings shall be effectively protected from mechanical damage. When necessary, magnets shall be provided with an efficient cushioning device. Two duties are recognized for both ac and dc, namely :

a) Continuous or heavy duty, and
b) Intermittent.

16.3 Brake Release

Appropriate mechanical, electro-hydraulic or any other alternative brake releasing gears may be used instead of brake magnets, if desired.

17 LIMIT SWITCHES

17.1 Limit switches shall be of the totally-enclosed quick-break type and where wired to three-phase motors, shall interrupt not more than two phases. Those incorporating a spring to provide quick breaking of the contacts shall be so designed and constructed that failure of the spring does not affect positive opening of the contacts.

17.1.1 Limit switches shall be of the series or shunt-type and shall permit the motor to be operated in the reverse direction, when the limit switch is opened. The limit switch after being tripped shall automatically reset itself within a reasonable distance travelled in the opposite direction. This does not prevent the use of the change over type limit switches, where the re-setting is achieved by striker when moving in the opposite direction.

18 ELECTRICAL PROTECTIVE DEVICES

18.1 Contactor, Circuit-Breaker

Operated as minimum equipment of protection, an electro-magnetically operated contactor with inherent under voltage protection together with overload devices shall be provided.

18.1.1 The overload protection may be of the electro-magnetic type, with time delay or thermal overload relays in conjunction with high rupturing capacity fuses or thermal sensing devices, sensitive to motor temperature or to temperature and current, which are thermally in contact with the motor windings.

18.1.2 The number of overload devices and their position shall normally be in accordance with one of the arrangements shown in Table 2. But if specified by the purchaser other arrangements giving protection of not less than any of these shall be considered as complying with the standard.

Table 2 Normal Requirements for Number of Protection Devices for Motor Circuits

(*Clause* 18.1.2)

Sl No.	dc Supply		3 Phase ac Supply
(1)	(2)	(3)	(4)
i)	No line earthed	One line earthed	–
ii)	2 per motion in separate line	1 per motion connected in the non-earthed line	3 per motion in separate lines

19 CABLES AND CONDUCTORS

19.1 Cables

Rubber PVC or varnished cambric insulated cables used for jib crane wiring shall comply with the relevant Indian Standard. All cables shall be adequately protected against mechanical damage and from damage by weather. Where metal conduits or flexible tubes are used, their ends shall be screwed-in adequately, to prevent ingress of moisture.

19.2 Minimum Size of Cables

Cables having conductors complying with the relevant Indian Standard, smaller than 2.5 mm^2 (nominal) equivalent copper area of cross-section shall not be used for the power wiring of the motor. For control circuits and auxiliary wiring cables having a sectional area smaller than 1.5 mm^2 (nominal) equivalent copper area shall not be used.

19.3 Multi-Core Armoured Cables

Multi-core armoured power and control cables suitably clamped may be used to avoid conduits and troughings. Suitable clamping glands should be provided at both ends of each multi-core cable.

19.4 Outdoor Jib Crane Wiring

For outdoor jib cranes, except where flexible un-armoured cables are essential, cables shall be either armoured or enclosed throughout their length in galvanized trunking or conduit, either flexible or rigid. A flexible metallic tube or duct may not form an effective earth connection and shall not be used for that purpose.

19.5 Current Rating

19.5.1 Rating of the cable, in the circuit related to mechanism class M6, shall be not greater than the appropriate values given in the relevant Indian Standard for continuous duty, giving due considerations to ambient temperature, type of excess current, protection, grouping and disposition of cables and voltage drop. Cables in circuit related to mechanism class below M8 may be rated higher in accordance with Table 3.

Table 3 Higher Rating of Cables

(*Clause* 19.5.1)

Sl No.	Mechanism Class	Stator Circuit Rating Multiplied by	Rotor & Resistor Circuits Rating Multiplied by
(1)	(2)	(3)	(4)
i)	M1, M2	2	2.5
ii)	M3, M4, M5	1.7	2
iii)	M6, M7	1.4	1.5

19.5.2 Consideration should be given to such factors as the ambient temperature, grouping and disposition of the cables, and to the limitations of voltage drop which influences selection of suitable cables.

20 EARTHING

20.1 The jib crane structure, motor frames and metal cases of all electrical equipment including metal conduit or cable guards, shall be effectively connected to earth at two different points.

20.2 Where the jib crane is connected to the supply by flexible cord or flexible cable, the crane shall be connected to earth by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord or flexible cable.

21 GUARDS

21.1 Where there is any possibility of any person coming in contact with an exposed part of an electrical circuit, other than one operating at extra low voltage, such part shall be effectively guarded.

21.2 All reciprocating and moving parts which might constitute a hazard shall be guarded.

21.3 All guards shall be preferably of hinged type.

22 CONDUCTORS AND CURRENT COLLECTORS

22.1 General

The type of current collecting system for cross travel motion shall be provided as required by the purchaser.

22.2 Trailing Cable Arrangement

In the trailing cable arrangement, the conductors shall be insulated flexible single or multiple core cables with permanent termination on the fixed part and moving part. The flexible trailing cables shall have sufficient length and shall be supported on trolley with clamps. The trolley shall run freely on a guide without undue stresses or wear on suspended cables.

22.3 Rating

Unless otherwise specified, the maximum current density shall not exceed 0.42 A/mm^2 for rolled steel section, 1.2 A/mm^2 for aluminum sections and 2.5 A/mm^2 for copper sections. The gap between the current collector and adjacent live or earth part shall not be less than 50 mm.

22.4 Cross Travel Current Collection System

22.4.1 *General*

Cross travel current collecting system shall be with bare conductors or with shrouded conductors or with trailing cable arrangement. The collection system shall be provided by the manufacturer.

22.4.2 *Conductors*

Cross travel conductors shall be arranged so that they are accessible for maintenance.

22.4.3 *Collector Assembly*

Collector assembly shall be rigidly mounted on the hoist trolley and shall be provided with reasonable accessibility to all parts for maintenance purpose.

SECTION 4

INSPECTION AND TESTING

23 GENERAL

23.1 If required by the purchaser and specified in the contract, the purchaser or his authorized representative shall have access to the manufacturer's works at all reasonable time for the purpose of witnessing the manufacture, inspection and testing of all products concerned and or the complete crane.

23.2 Any work found defective or which is not in accordance with the drawings or of terms of this Code and/or the contract may be rejected by the inspector.

24 TESTS AT MANUFACTURER'S WORKS

24.1 All electrical and mechanical equipment shall be tested in accordance with the appropriate Indian Standard at either the crane maker's or equipment manufacturer's works and test certificates provided if required by the purchaser.

24.2 As the jib crane is designed and manufactured to suit customer's location and foundations, and in some cases in existing columns, the manufactured crane shall be dimensionally checked at the manufacturer's works, and also subjected to the visual inspection. The full load test and 25 percent overload test on hoisting, cross travel and slewing motion shall be done at customer's site after installing the jib crane on the foundation or customers column.

24.3 Any other test required by the purchaser beyond those called for in the appropriate Indian Standard shall be subject to mutual agreement and shall be carried out at the purchaser's expenses.

25 TESTS ON PURCHASER'S PREMISES

25.1 Insulation Tests

After erection, but before the jib crane is connected to the supply, the insulation of the electrical equipment shall be tested by a suitable instrument and any defects revealed shall be rectified.

25.1.1 The voltage required for the insulation resistance test shall be a dc voltage not less than twice the rated voltage.

25.1.2 Any reading less than 0.5 mΩ obtained with a 500 V dc Megar of the unregulated type shall be disregarded and the wiring under test shall be subdivided until a reading higher than 0.5 mΩ is obtained. Failure to obtain a higher reading shows an unsatisfactory state of the insulation.

25.1.3 The insulation resistance of each wiring circuit exclusive of connected apparatus shall be not less than 2 mΩ. If necessary, it shall be permissible to disconnect individual items of equipments while making this test.

25.1.4 The basic parameters like crane dimensions and clearance shall be verified. The height of lift shall be measured at site after erection.

25.1.5 The speed-load characteristics of the various motions of the crane offered by the manufacturer may be verified by the purchaser at his premises by actual loading such as no-load, half-load and full-loads. Any deviation shall be corrected by the manufacturer with a tolerance on speed of 10 percent in the working conditions.

25.2 Test of Operation

After the supply has been connected, and before the complete crane installation is put into commercial service tests shall be carried out to prove the following :

a) Satisfactory operation of all control devices and in particular the correct operation of limit switches;

b) Correctness of all circuits and interlocks and sequence of operations;

c) Satisfactory operation of all protective devices;

d) Satisfactory operation of each motion of the crane;

e) Compliance of the crane with the specified performance requirements;

f) Tolerance on specified speeds at full load shall be within ± 10 percent; and

g) Deflection measurement test when the load is at extreme end of the boom.

NOTE — In the case of erection of jib crane by a party other than the supplier, the purchaser shall ensure that the erection of the jib crane, has been done according to the supplier's recommendations/instructions.

26 OVER LOAD TESTS

26.1 After tests of operation, but before the crane is put into service, it shall, with overload relays appropriately set, be tested to lift and sustain a test load of 125 percent of the working load, when the load is located at the maximum boom radius.

26.2 During the overload test, each motion in turn shall be maneuvered in both directions and the crane shall sustain the load under full control. The specified speeds need not be attained but the crane shall show itself of dealing with the overload without difficulty.

ANNEX A

(Foreword)

LIST OF ADJUNCT INDIAN STANDARDS

A-1 MATERIALS

A-1.1 Steels and Castings

IS No.	*Title*
210 : 1993	Grey iron casting (*fourth revision*)
1030 : 1998	Carbon steel castings for general engineering purposes (*fifth revision*)
1387 : 1993	General requirement for the supply of metallurgical materials (*second revision*)
1570	Schedules for wrought steels:
(Part 1) : 1978	Steels specified by tensile and/or yield properties (*first revision*)
(Part 2/Sec 1) : 1979	Carbon steels (unalloyed steels), Section 1 Wrought products (other than wires) with specified chemical composition and related properties (*first revision*)
(Part 2/Sec 2) : 1987	Carbon steels (unalloyed steels), Section 2 Carbon wires with related properties (*first revision*)
(Part 3) : 1979	Carbon and carbon manganese free cutting steels (*first revision*)
(Part 4) : 1988	Alloy steels (alloy constructional and spring steels) with specified chemical composition and mechanical properties (*first revision*)
(Part 5) : 1985	Stainless and heat resisting steels (*second revision*)
(Part 6) : 1996	Carbon and alloy tools steels (*first revision*)

IS No.	*Title*
(Part 7) : 1992	Steels for elevated temperature service (creep resistant steels)
1875 : 1992	Carbon steel billets, blooms, slabs and bars for forgings (*fifth revision*)
2062 : 1999	Steel for general structural purpose (*fifth revision*)
8500 : 1991	Structural steel micro-alloyed (medium and high strength qualities) (*first revision*)

A-1.2 Threaded Fastners

1364	Hexagon head bolts, screws and nuts of product grades A and B:
(Part 1) : 1992	Hexagon head bolts (size range M16 to M64) (*third revision*)
(Part 2) : 1992	Hexagon head screws (size range M16 to M64) (*third revision*)
(Part 3) : 1992	Hexagon nuts (size range M16 to M64) (*third revision*)
1367	Technical supply conditions for threaded steel fasteners:
(Part 1) : 1980	Introduction and general information (*second revision*)
(Part 2) : 1979	Product grade and tolerances (*second revision*)
(Part 3) : 1991	Mechanical properties and test methods for bolts, screws and studs with full loadability (*third revision*)
(Part 5) : 1980	Mechanical properties and test methods for set screws and similar threaded fasteners not under tensile stresses
(Part 6) : 1994	Mechanical properties and test methods for nuts with specified proof loads (*third revision*)
(Part 7) : 1980	Mechanical properties and test methods for nuts without specified proof loads (*second revision*)
(Part 8) : 1992	Mechanical and performance properties for prevailing torque type steel hexagon nuts (*second revision*)
(Part 9/Sec 1) : 1993	Surface discontinuities, Section 1 Bolts, screws and studs for general application (*third revision*)
(Part 9/Sec 2) : 1993	Surface discontinuities, Section 2 Bolts, screws and studs for special application (*third revision*)
(Part 10) : 1979	Surface discontinuities on nuts (*second revision*)
(Part 11) : 1996	Electroplated coatings
(Part 12) : 1981	Phosphate coatings on threaded fasteners (*second revision*)
(Part 13) : 1983	Hot-dip galvanized coatings on threaded fasteners (*second revision*)
(Part 14) : 1984	Stainless steel threaded fasteners (*second revision*)
(Part 16) : 1979	Designation system and symbols (*first revision*)
(Part 17) : 1996	Inspection, sampling and acceptance procedure (*third revision*)
(Part 18) : 1979	Packaging (*third revision*)

A-1.3 Wire Rope

1856 : 1977	Steel wire rope for haulage purposes (*second revision*)
2266 : 2002	Specification for steel wire ropes for general engineering purposes (*fourth revision*)
2365 : 1977	Specification for steel wire suspension ropes for lifts, elevators and hoists (*first revision*)
2762 : 1982	Wire rope slings and sling legs (*first revision*)
3973 : 1984	Code of practice for selection, installation and maintenance of wire rope (*first revision*)
6594 : 2001	Technical supply conditions for steel wire ropes and strands (*second revision*)

A-2 MECHANICAL AND FABRICATION DETAILS

A-2.1 Keys and Keyways

2048 : 1983	Specification for parallel keys and keyways (*second revision*)
2291 : 1990	Specification for tangential keys and keyways (*third revision*)
2292 : 1974	Specification for taper keys and keyways (*first revision*)

IS No.	*Title*
2293 : 1974	Specification for Gib-head keys and keyways (*first revision*)
6166 : 1971	Thin taper keys and keyways
6167 : 1971	Thin parallel keys and keyways

A-2.2 Welding

816 : 1969	Code of practice for use of metal arc welding for general construction in mild steel (*first revision*)
818 : 1968	Code of practice for safety and health requirements in electric and gas welding and cutting operations (*first revision*)
822 : 1970	Code of procedure for inspection of welds
1024 : 1999	Code of practice for use of welding in bridges and structures subject to dynamic loading (*second revision*)
1323 : 1982	Code of practice for oxy-acetylene welding for structural work in mild steel (*second revision*)

A-2.3 Gears

2467 : 1963	Notation for toothed gearing
2535 : 1978	Basic rack and modules of cylindrical gears for general engineering and heavy engineering (*second revision*)
3734 : 1983	Dimensions for worm gearing (*first revision*)
4460 (Parts 1 to 3) : 1995	Gears — Spur and helical gears— Calculation of load capacity (*first revision*)
6535 : 1979	Data for procurement cylindrical bevel gears (*first revision*)
7403 : 1974	Code of practice for selection of standard worm and helical gear boxes
7504 : 1995	Gears — Cylindrical gears — Accuracies — Methods of inspection (*first revision*)
10911 : 1984	Method of inspection for straight bevel gears

A-3 ELECTRICAL DETAILS

A-3.1 Motors

IS No.	*Title*
325 : 1996	Specification of three phase induction motors (*fifth revision*)
900 : 1992	Code of practice for installation and maintenance of induction motors (*second revision*)
1231 : 1974	Dimensions of three phase foot mounted induction motors (*third revision*)
2223 : 1983	Dimensions of flange mounted ac induction motor (*first revision*)
4691 : 1985	Degrees of protection provided by enclosure for rotating electrical machinery (*first revision*)
12075 : 1987	Mechanical vibration of rotating electrical machines with shaft height 56 mm and higher, measurement, evaluation and limits of vibration severity

A-3.2 Cables and Conductors

694 : 1990	Specification for PVC insulated cables for working voltages up to and including 1 100 V (*third revision*)
1554	Specification for PVC insulated (heavy duty) electric cables:
(Part 1) : 1988	For working voltages upto and including 1 100 V (*third revision*)
(Part 2) : 1988	For working voltages from 3.3 kV upto and including 11 kV (*third revision*)
8130 : 1984	Conductors for insulated electric cables and flexible cords (*first revision*)
9968 (Part 1) : 1988	Elastomer insulated cables : Part 1 For working voltages up to and including 1 100 V (*first revision*)

A-3.4 Conduits

9537 (Part 3) : 1983	Conduits for electrical installation: Part 3 Rigid plain conduits of insulating materials

A-3.4 Switchgears

IS No.	*Title*
3427 : 1997	ac metal enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 11 kV
10118	Code of practice for selection, installation and maintenance of switchgear and controlgear:
(Part 1) : 1982	General
(Part 2) : 1982	Selection
(Part 3) : 1982	Installation
(Part 4) : 1982	Maintenance
13118 : 1991	High voltage alternating current circuit breakers
13947	Low voltage switchgear and controlgear :
(Part 1) : 1993	General rules
(Part 2) : 1993	Circuit breakers
(Part 3) : 1993	Switches, disconnectors, switch disconnectors and fuse combination units
(Part 4/Sec 1) : 1993	Contractors and motor starters, Section 1 Electro-mechanical contractors and motor starters
(Part 5/Sec 1) : 1993	Control circuit devices and switching elements, Section 1 Electro-mechanical control circuit devices

A-3.5 Earthing

3043 : 1987	Code of practice for earthing (*first revision*)

A-3.6 Cranes and Hoist

807 : 1976	Code of practice for design, manufacture, erection and testing (structural portion) of cranes and hoists (*first revision*)
3177 : 1999	Code of practice for electric overhead travelling cranes and gantry cranes other than steel work cranes (*second revision*)
3832 : 1986	Hand operated chain pulley blocks (*second revision*)
3938 : 1983	Specification for electric wire rope hoists (*second revision*)
13473 (Part 1) : 1992	Cranes — Vocabulary: Part 1 General

ANNEX B

(*Clause* 4.1)

INFORMATION TO BE SUPPLIED WITH THE ENQUIRY OR ORDER

The following information in regard to the details of the crane shall be furnished by the purchaser at the time of enquiry or order :

a) **General**

1) Number of jib cranes .....
2) Whether manual/electrical for hoist/CT/ swivel
3) Group classification of the mechanism
   i) Jib crane structure (*see* IS 807) .....
   ii) Hoist (*see* IS 3832 or IS 3938) .....
   iii) Cross traverse (*see* IS 3832 or IS 3938).....
4) Safe working load, in tonnes :
   Hoist .....
5) Whether the crane is to work in an enclosed building or outdoors.....
6) Any abnormal atmospheric condition .....
   (soil bearing capacity/soil condition at site)
7) A write-up on application details .....
8) Type of jib crane desired/select from attached clearance diagrams .....
9) Any special requirements likely to affect design .....

b) **Jib Crane Performance**

1) Operating speeds (loaded), in m/min :
   i) Main hoist .....
   ii) Micro speed (if required) .....
   iii) Cross traverse .....
   iv) Slew motion at tip of boom (if motorized typed) .....
2) Type of control required .....
3) Boom length/effective working radius.....

4) Clear lift :
   i) above floor level .....
   ii) below floor level .....
5) Overall height restriction, if any .....

c) **Electrical Details**

1) Power supply ac or dc :
   Volts ..... No. of phases.....
   frequency .....
   No. of wires ..... Neutral (earthed or not) .....
2) Controls :
   i) Type of pendant — moving with hoist along the span of the jib
   ii) Control voltage — or stationery, mounted on column
3) Ambient temperature to degree centigrade :
   i) Maximum .....
   ii) Minimum .....
   iii) Maximum humidity.....
4) Details of motors .....
5) Arrangement of drives .....
6) Contactor control details .....

d) **Lifting Hook**

Type of hook (standard single shank 'C' hook or rams horn type) :

1) Hoist .....
2) If safety latch required .....
3) If hook swiveling lock required .....
4) Height of hook above floor level, h_1: .....
5) Drop of hook below floor level, h_2 : .....

e) **Any Special Requirement/Accessories**

Such as lifting beam/hook lighting magnet, grab bucket, etc.

ANNEX C

(*Clause* 4.2)

INFORMATION TO BE SUPPLIED BY MANUFACTURER

The following details in regard to the crane should be supplied to the purchaser at the time of enquiry and order. Letters in parentheses refer to those in Fig. 1 to Fig. 8 :

a) Type of jib crane :
   1) Jib crane structure.....
   2) Hoist .....
   3) Cross traverse .....
b) Safe working load
   1) Hoist .....
   2) Boom radius *(R)* .....
c) Operating speeds (loading)
   1) Hoist.....m/min
   2) Micro speed (if applicable).....m/min
   3) Cross traverse .....m/min
   4) Acceleration values for cross travel motions ..... (normal 10 m/s)
   5) Slew motion at tip of boom .....m/min
d) Type of hook supplied :
   Hoist .....
e) Height of hook above floor level :
   Hoist (h_1) .....m
f) Drop of hook below floor level :
   Hook (h_2) .....m.
g) Hoisting rope :
   Diameter/Construction/Quality of rope
   Breaking load .....
   1) Hoist .....
   2) Factor safety .....
h) Description of brakes :
   1) Hoisting-motion brakes (*S*) .....
   2) Traversing brakes (*S*) .....
j) Power supply, ac .....
   Volts.....Phase.....Frequency.....
   Number of wires .....
k) Motors :
   Temperature rise .....

Motion	*Quantity*	*Type*	*Metric Horse Power*	*Min/rev*	*Enclosure*	*Rating*
Hoist						
Cross Travel						

m) Details of controllers control panel and equipment

n) Control voltage ac .....

p) Particulars of safety devices

q) Net mass :

1) Complete unladen jib crane..... tonnes

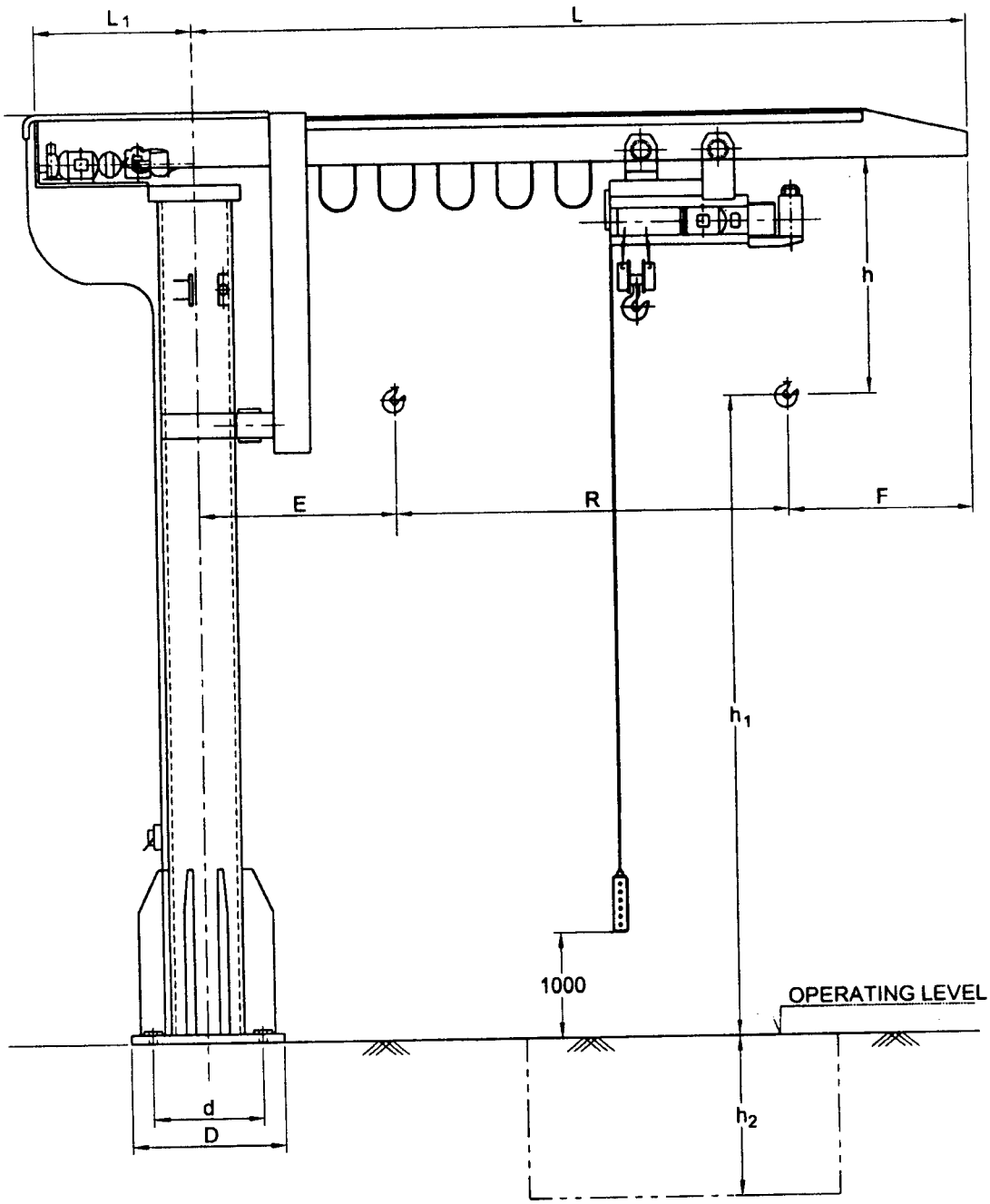
2) Complete unladen hoist ..... tonnes

r) Tools and accessories supplied .....

s) Other information not scheduled above .....

t) General arrangement :

Drawing number .....



L = boom length
L_1 = extension on other side
R = effective radius
E = hook approach
F = hook approach
h = head room of hoist
h_1 = height of lift
h_2 = lift below the floor level
H = overall height
d = pitch circle diameter of bolts
D = base diameter

FIG. 1 SELF SUPPORTED JIB CRANE ELECTRICALLY OPERATED 360° SWIVEL

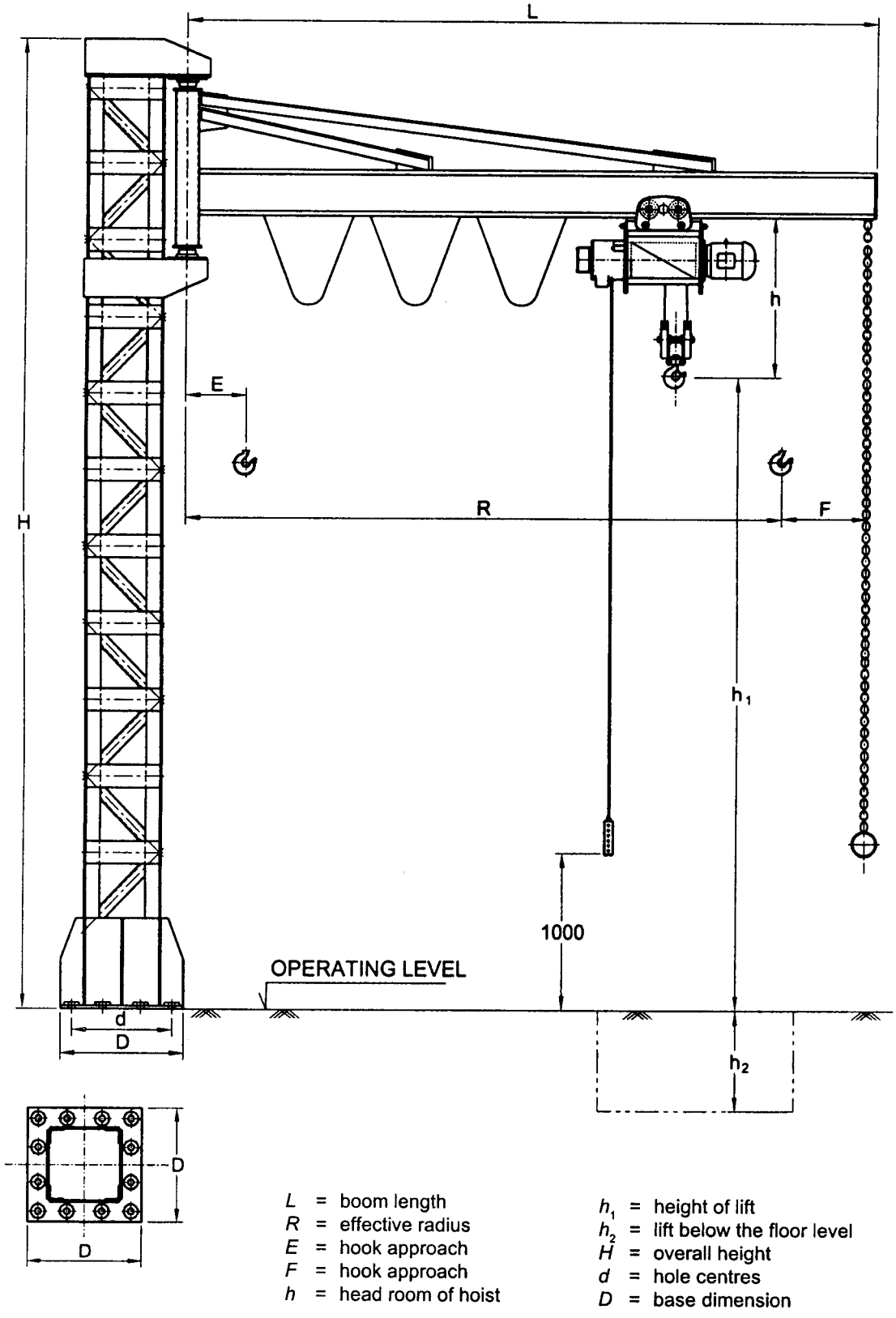
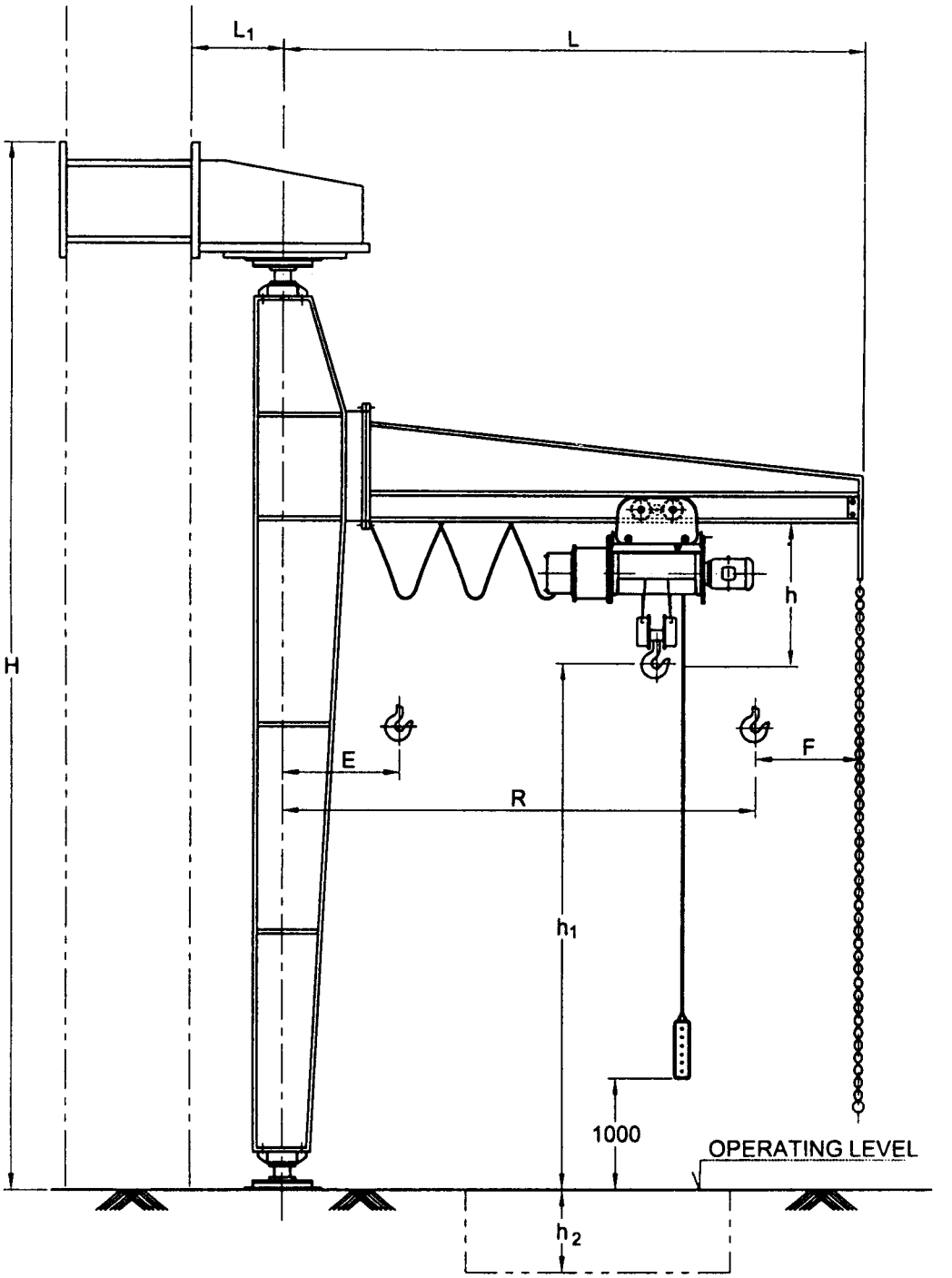
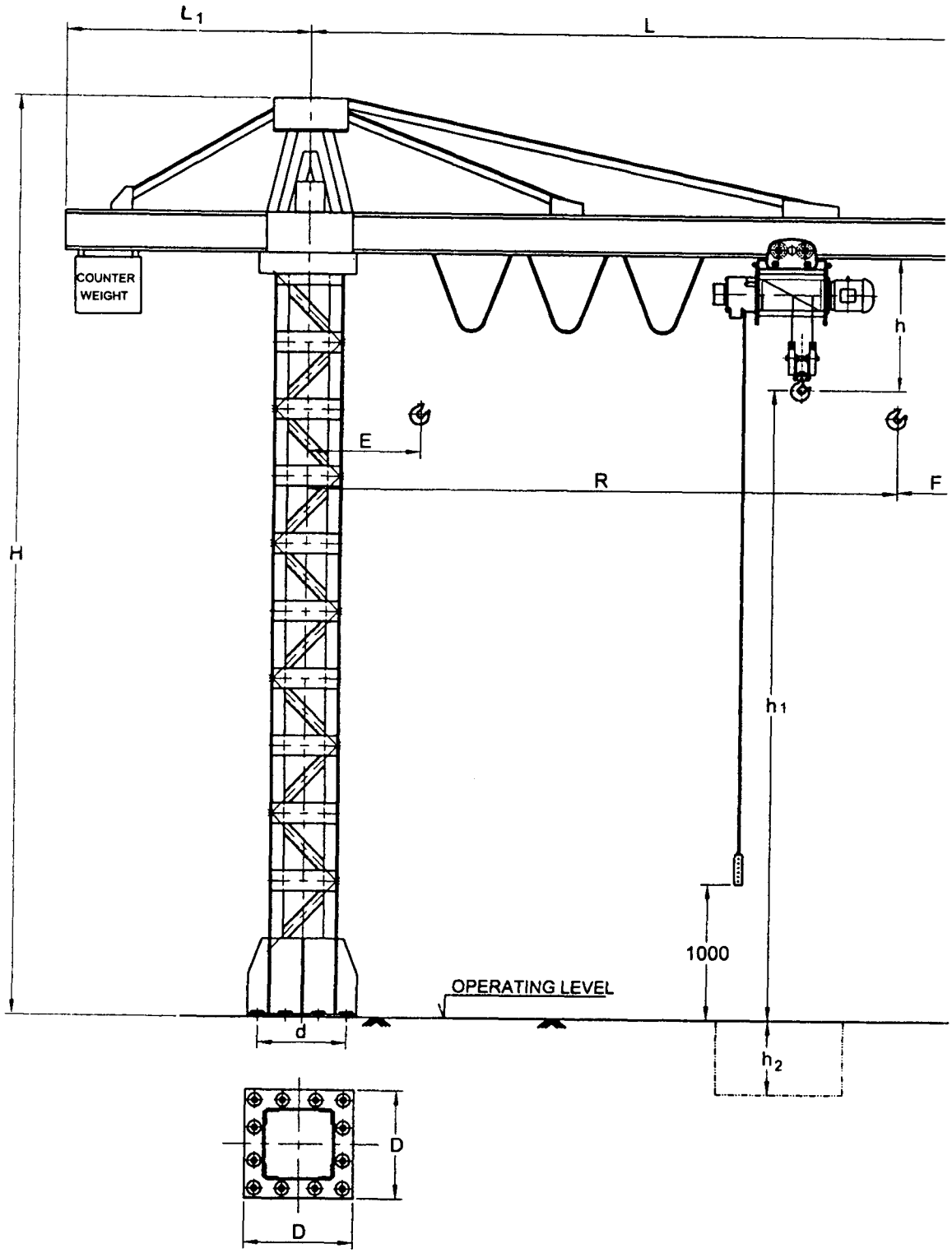


FIG. 2 SELF SUPPORTED JIB CRANE WITH FABRICATED COLUMN, ELECTRICALLY OPERATED 180° SWIVEL



L = boom length
L_1 = extension on other side
R = effective radius
E = hook approach
F = hook approach
h = head room of hoist
h_1 = height of lift
h_2 = lift below the floor level
H = overall height

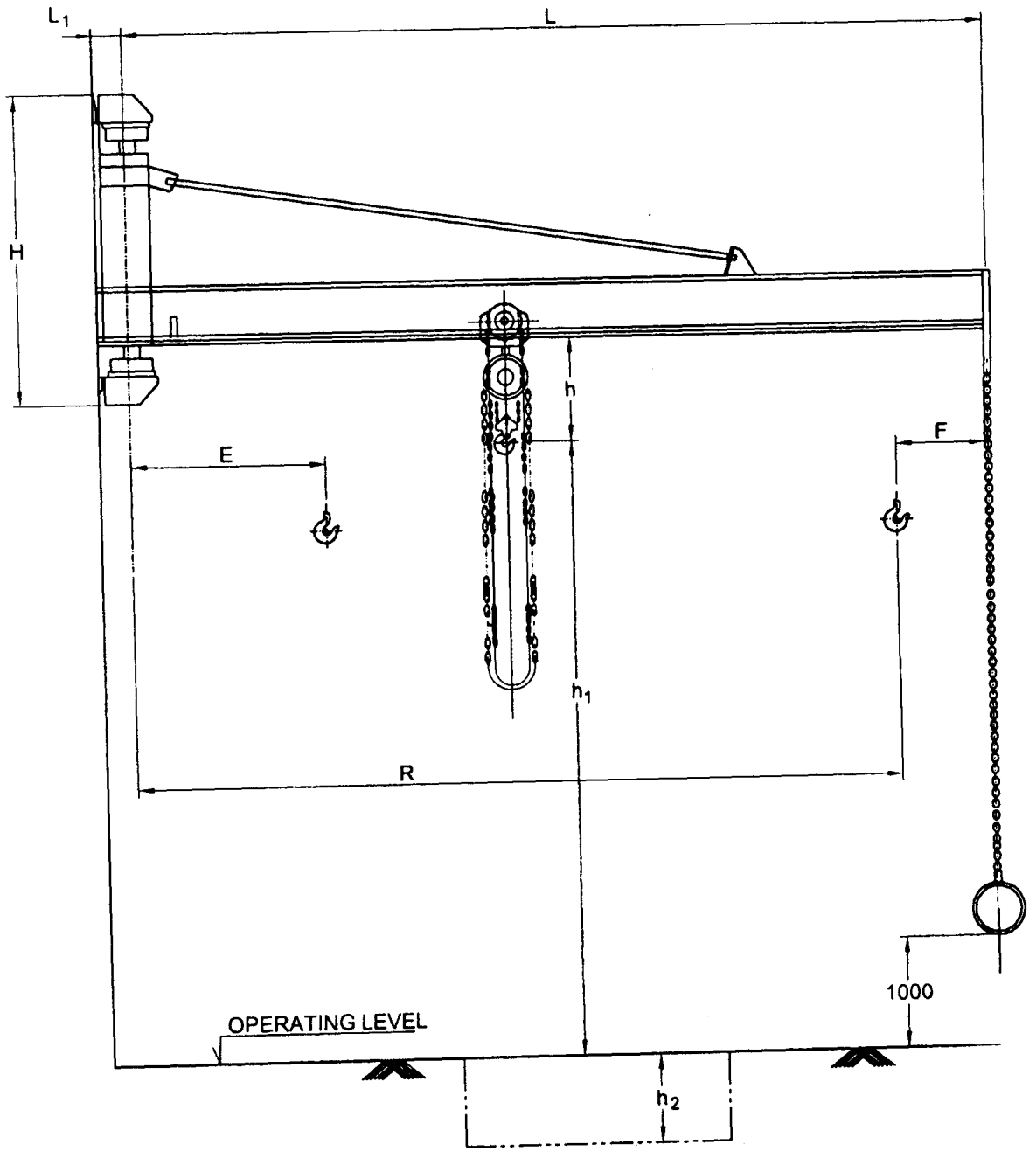
FIG. 3 KING POST TYPE JIB CRANE ELECTRICALLY OPERATED 180° SWIVEL



L = boom length
L_1 = extension on other side
R = effective radius
E = hook approach
F = hook approach

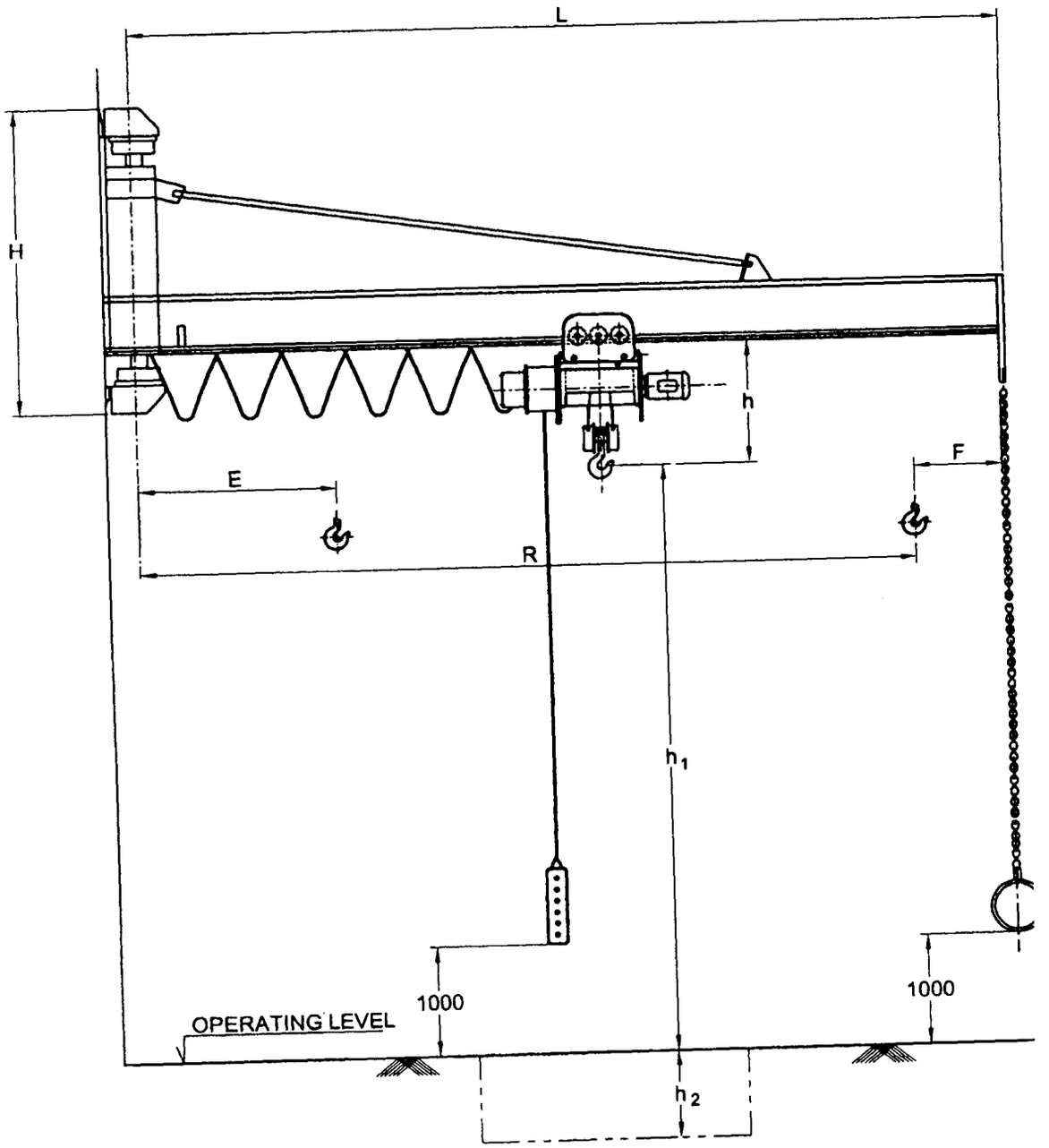
h = head room of hoist
h_1 = height of lift
h_2 = lift below the floor level
H = overall height
D = base length
d = hole centres

FIG. 4 SELF SUPPORTED JIB CRANE WITH COUNTER WEIGHT FABRICATED COLUMN TYPE ELECTRICALLY OPERATED 360° SWIVEL



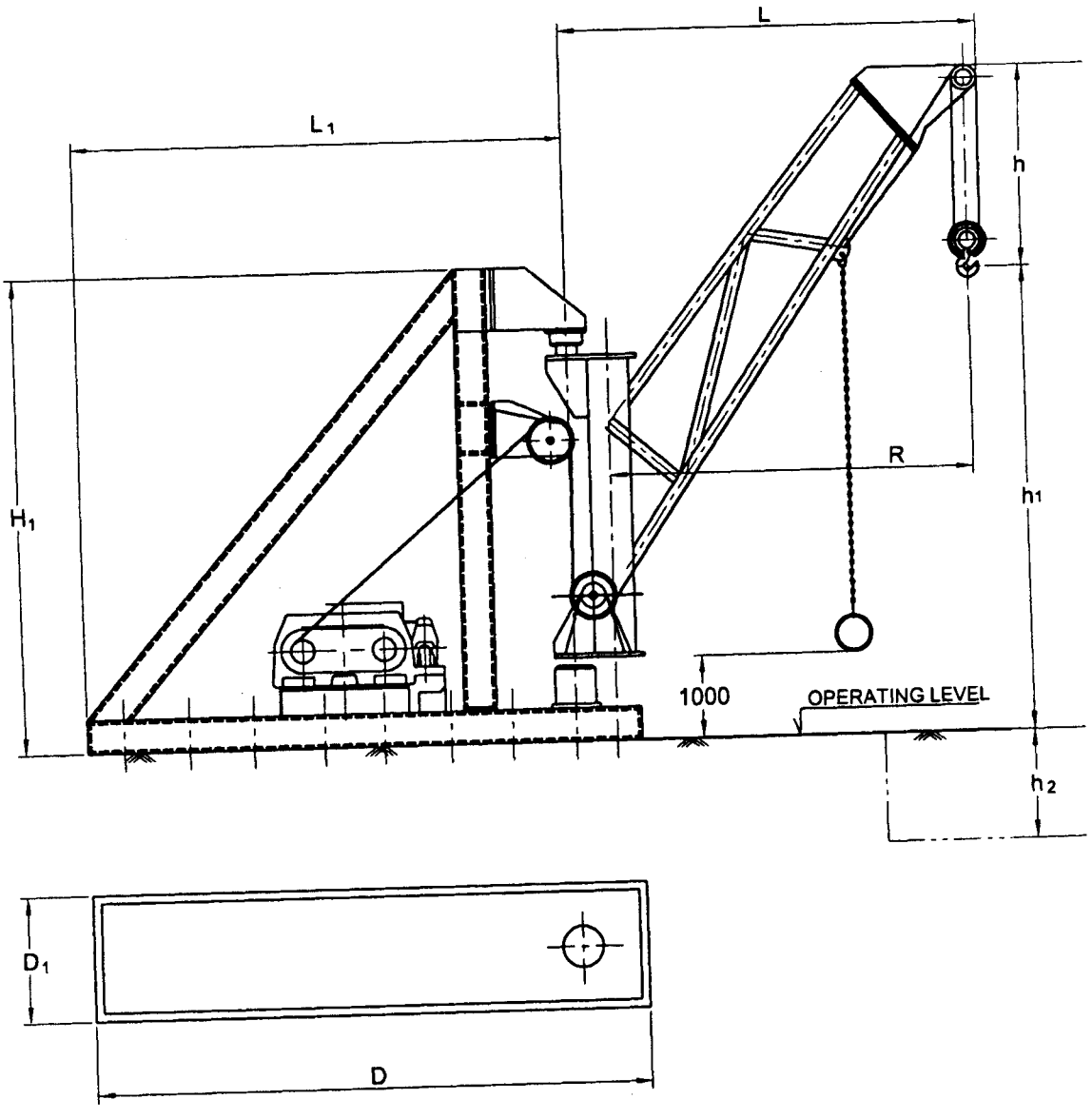
L = boom length
L_1 = extension on other side
R = effective radius
E = hook approach
F = hook approach
h = head room of hoist
h_1 = height of lift
h_2 = lift below the floor level
H = overall height

FIG. 5 WALL MOUNTED BRACKET TYPE JIB CRANE
HAND OPERATED 180° SWIVEL



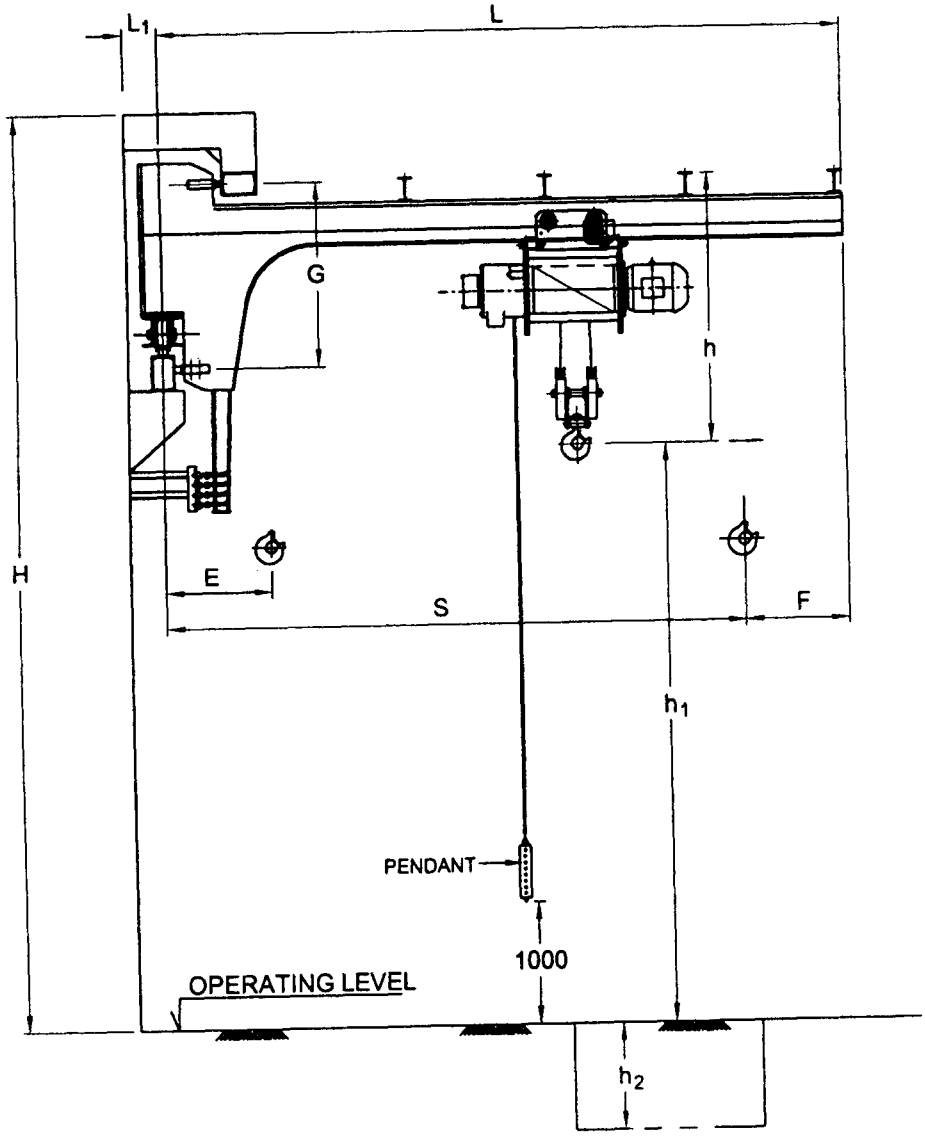
L = boom length
R = effective radius
E = hook approach
F = hook approach
h = head room of hoist
h_1 = height of lift
h_2 = lift below the floor level
H = overall height

FIG. 6 WALL MOUNTED BRACKET TYPE JIB CRANE ELECTRICALLY OPERATED 180° SWIVEL



L = boom length
L_1 = extension on other side
R = effective radius
h = head room of hoist
h_1 = height of lift
h_2 = lift below the floor level
H = overall height
$D \times D$ = base dimension

FIG. 7 ROTARY JIB CRANE WITH EXTENDED DERRICK BOOM



L = boom length
L_1 = extension on other side
S = effective radius
E = hook approach
F = hook approach
h = head room of hoist
h_1 = height of lift
h_2 = lift below the floor level
H = overall height
G = support roller centres

FIG. 8 MOVING CANTILEVER WALL CRANE ELECTRICALLY OPERATED

ANNEX D

(*Clause* 11.2.1)

PROCEDURE FOR CALCULATING LOCAL BENDING OF THE BOTTOM FLANGE OF A MONO-RAIL TRACK

The bottom flange of monorail track over which the trolley of a hoist travels (*see* Fig. 9) is subjected to stresses in bending due to the mass of the girder proper and to the stress resulting from the local bending under a concentrated load P that is the wheel pressure. The girder flange is treated as a plate of infinite length rigidly attached to the web along one edge while the other is free. The bending stress set up in the section, at its bottom (at point B of Fig. 9) by the mass of the girder, properly suspended from the hanger brackets spaced at distance L apart can be calculated from.

$$\sigma_{yb} = \frac{M_{byz}}{W_{xB}}$$

where M_{byz} is the bending moment set up by the combined effect of all the forces (concentrated external load and uniformly distributed mass of rail with weight of per unit length) at a section midway between the points of suspension :

W_{xB} is the section modulus of girder.

The stress resulting from the local bending in the root section can be estimated in plane xy by :

$$\sigma_x = \frac{6\,K_1.P}{t^2_{root}}$$

and in the plane yz by

$$\sigma_y = \frac{6\,K_2.P}{t^2_{root}}$$

where the stress at point A is regarded as being positive and that bottom of root section as negative.

The stress set up by local bending along the free end of the flange which is parallel to plane yz is determine from

$$\sigma_{yfree} = \frac{6\,K_3.P}{t^2_{mean}}$$

where the stress at point B is regarded as being positive and that the top of the flange, as negative : K_1, K_2, K_3 are the coefficients varying with the ratio c/a : and obtainable from the curve in Fig. 10; t_{mean} is the flange thickness at midsection (refer to Fig. 10 for K_1, K_2, K_3, values).

The point of maximum stress will be either at A or B depending on the position of the load P.

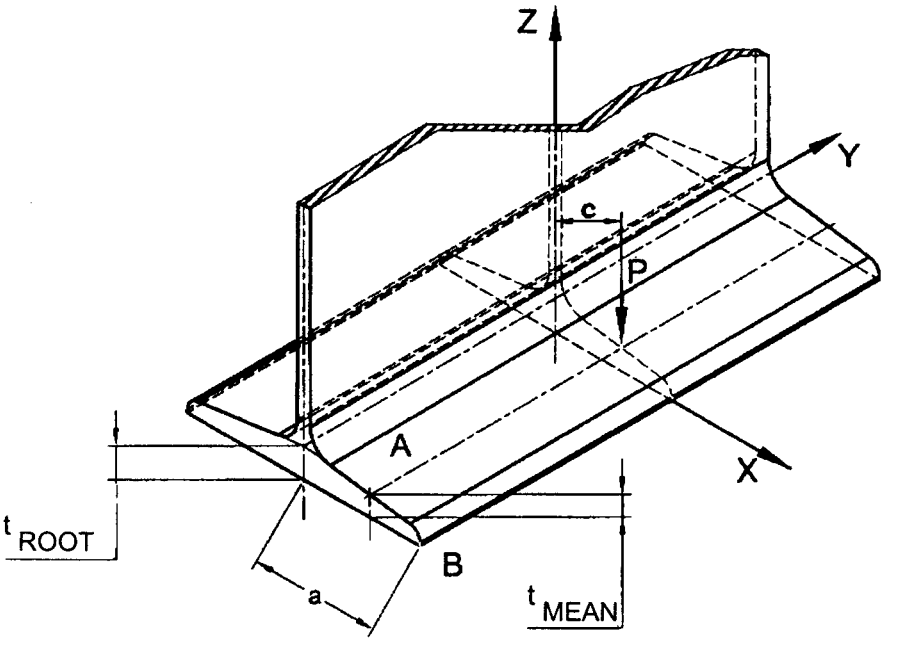
The modified stress at point B is obtainable from

$$\sigma_{B(act)} = \sigma_{yfree} + \sigma_{yb} \ldots\ldots \leq \sigma_{B(allowable)}$$

The modified stress at point A can be obtainable on the basis of strain energy.

$$\sigma_{A(act)} = \sqrt{\sigma_x^2 + (\sigma_y + \sigma_{yb})^2 - \sigma_x(\sigma_y + \sigma_{yb})} \ldots\ldots$$
$$\ldots\ldots \leq \sigma_{A(allowable)}$$

where the allowable stress at point B of girder of mild steel conforming to IS 2062 quality is $\sigma_{B(allowable)} = 1\,800$ kg/cm^2 and that point A is $\sigma_{A(allowable)} = 2\,000$ kg/cm^2. An increase in the allowable stress is attributed to the effect of cold work resulting from the concentrated load imposed by the track wheels.



σ_{yb} = bending stress induced at point 'B'.

M_{byz} = bending moment induced by the combined effect of all the forces (concentrated external load *P* and uniformly distributed mass of monorail with weight of '*q*' per unit length '*l*') at a section midway between the points of suspensions).

W_{xB} = section modulus of the monorail girder.

σ_x = stress resulting from local bending in the root section in plane *xy*.

σ_y = stress resulting from local bending in the root section in plane *yz*.

A = top surface of the girder bottom flange.

B = bottom surface of the monorail girder flange.

c = distance from centre of web at which concentrated load *P* is acting in cm.

$\sigma_{A(allowable)}$ = allowable stress at point '*A*'.

$\sigma_{B(allowable)}$ = allowable stress at point '*B*'.

t_{mean} = bottom flange thickness at mid section.

t_{root} = bottom flange thickness at the root.

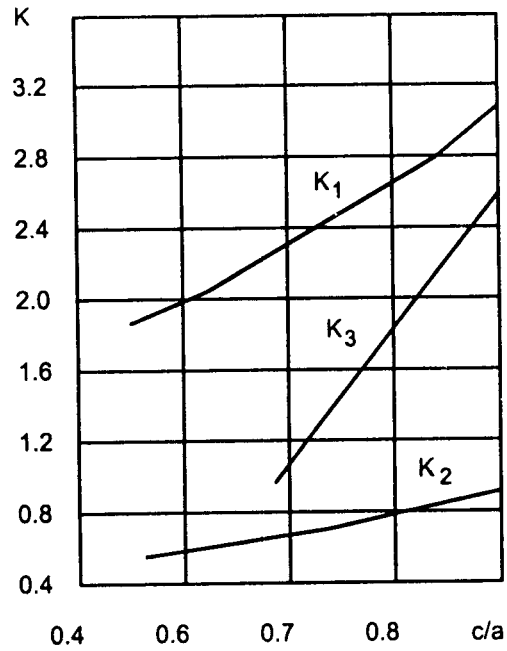
a = half width of the bottom flange of the mono-rail

l = unit length of mono-rail, in cm

L = length of mono-rail beam at suspensions, in cm

q = weight per unit length of mono-rail, in kg/cm.

FIG. 9 DESIGNING OF MONO-RAIL TRACK FOR STRENGTH



NOTE — K_1, K_2 and K_3 = Coefficients varying with the ratio of C/a and obtainable from curve as given in Fig. 10.

FIG. 10 VALUE OF COEFFICIENTS K_1, K_2 AND K_3

ANNEX E

(Foreword)

COMMITTEE COMPOSITION

Cranes and Lifting Chains Sectional Committee, MED 14

Organization	*Representative(s)*
Bharat Heavy Electricals Ltd, Tiruchirappalli	SHRI K. MANICKAM (***Chairman***)
Armsel MHE Pvt Ltd, Bangalore	SHRI A. C. HERI SHRI N. VASUDEVA (*Alternate*)
Auri Industries India (P) Ltd, Pune	SHRI M. N. DANTWALA
Bharat Heavy Electricals Ltd, Hyderabad	SHRI GIRISH SHRIVASTAVA SHRI M. SUBBA RAO (*Alternate*)
Bhartiya Cutler-Hammer, Faridabad	SHRI V. RAMACHANDRAN SHRI VIRENDER SINGH (*Alternate*)
Braithwaite & Co Ltd, Kolkata	SHRI S. K. GANGOPADHYAY SHRI A. P. SAHA (*Alternate*)
Central Building Research Institute, Roorkee	SHRI R. L. GUPTA SHRI D. K. GAUTAM (*Alternate*)
Coal India Ltd, Kolkata	SHRI R. DASGUPTA
Directorate General Factory Advice Service & Labour Institute, Mumbai	SHRI M. A. BALAKRISHNAN SHRI G. M. K. RAJ (*Alternate*)
Directorate General of Suppplies & Disposals, New Delhi	SHRI R. C. GUPTA SHRI J. K. KHANNA (*Alternate*)
Escorts Construction Equipment Ltd, Faridabad	SHRI PRADEEP K. TYAGI SHRI RAVINDRA LUTHRA (*Alternate*)
Furnance and Foundry Equipment Co, Mumbai	SHRI SHYAM M. GURNANI
Hercules Hoists Ltd, Mumbai	SHRI P. B. KUCHERIA SHRI H. A. NEVATIA (*Alternate*)
Hindustan Shipyard Ltd, Visakhapatnam	SHRI D. V. S. N. RAJU SHRI B. KRISHNAPPA (*Alternate*)
Indian Chain Pvt Ltd, Kolkata	SHRI P. CHITLANGIA SHRI LALITMOHAN (*Alternate*)
Indian Link Chain Manufacturers Ltd, Mumbai	SHRI P. K. NEVATIA
Jessop & Co Ltd, Kolkata	SHRI BIMAL CHANDRAPAL SHRI TAPAN DATTA (*Alternate*)
Larsen & Toubro Limited, Kolkata	SHRI M. S. CHAKRABORTHY SHRI L. N. MISHRA (*Alternate*)
Lifting Equipment and Accessories Ltd, Delhi	SHRI RAJIV KHETAN
Mega Drives Pvt Ltd, Thane	SHRI MAJUMDAR SHRI N. B. BHUJLE (*Alternate*)
Metallurgical & Engineering Consultants (I) Ltd, Ranchi	SHRI T. K. ROY SHRI H. S. SINGH (*Alternate*)
M.N. Dastur & Co Ltd, Kolkata	SHRI D. GHOSH SHRI G. C. BANERJEE (*Alternate*)
Ministry of Defence (DGI), New Delhi	SHRI K. PARTHIBAN SHRI RAJINDER SINGH (*Alternate*)
Ministry of Surface Transport, New Delhi	SHRI T. K. DATTA
Mukand Ltd, Thane	SHRI D. CHAKRABORTHY SHRI D. S. SENTHILVEL (*Alternate*)

(*Continued on page* 26)

(*Continued from page* 25)

Organization	*Representative(s)*
National Thermal Power Corporation Ltd, New Delhi	SHRI B. K. BHATTACHARYA SHRI R. S. YADAV (*Alternate*)
Project and Development India Ltd, Dhanbad	SHRI L. C. DADLANI SHRI R. N. PRASAD (*Alternate*)
Research Designs & Standards Organization, Lucknow	SHRI R. N. HALDAR
Reva Engineering Industrial (P) Ltd, New Delhi	SHRI BALRAJ GOEL SHRI R. K. GANDHI (*Alternate*)
Southern Structural Ltd, Chennai	SHRI J. KUMARAN SHRI C. SELVAKUMAR (*Alternate*)
Steel Authority of India Ltd, Bhilai	SHRI K. DHARMARAJAN SHRI M. K. MUKHERJEE (*Alternate*)
Tata Engineering & Locomotive Co Ltd, Pune	SHRI R. K. JOSHI SHRI S. MISHRA (*Alternate*)
Tata Iron and Steel Company Limited, Jamshedpur	SHRI D. P. RATHORE SHRI J. P. SINGH (*Alternate*)
Tractor India Ltd, Kolkata	SHRI SRIMANTA DATTA SHRI A. K. HALDER (*Alternate*)
Tractel Tirfor (India) Ltd, New Delhi	DR P. K. CHAKRAVARTY SHRI SAURABH RAJOURIA (*Alternate*)
Unicon Technology International Pvt Ltd, New Delhi	SHRI R. S. NALWA SHRI MANISH NALWA (*Alternate*)
WMI Cranes Ltd, Mumbai	SHRI S. M. MALANI
BIS Directorate General	SHRI M. L. CHOPRA, Director & Head (MED) [Representing Director General (*Ex-officio*)]

Member Secretary
SHRI S. B. ROY
Director (MED), BIS

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act,* 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc : No. ME 14 (0616).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters :

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002
Telephones : 2323 0131, 2323 33 75, 2323 9402

Telegrams : Manaksanstha
(Common to all offices)

Regional Offices :		Telephone
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110 002	2323 7617, 2323 3841
Eastern	: 1/14 C.I.T. Scheme VII M, V. I. P. Road, Kankurgachi, KOLKATA 700 054	2337 8499, 2337 8561, 2337 8626, 2337 9120
Northern	: SCO 335-336, Sector 34-A, CHANDIGARH 160 022	60 3843, 60 9285
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600 113	2254 1216, 2254 1442, 2254 2519, 2254 2315
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East), MUMBAI 400 093	2832 9295, 2832 7858, 2832 7891, 2832 7892

Branches : AHMEDABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR. NALAGARH. PATNA. PUNE. RAJKOT. THIRUVANANTHAPURAM. VISAKHAPATNAM.

Printed at Prabhat Offset Press, New Delhi-2